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ABSTRACT

In order to study the concept of computer literacy and its implications for education, a review was made of the relevant professional, trade, and technical literature, with emphasis on information printed from 1978 to the present which highlights the development, growth, and present status of computer literacy in public schools. Recent developments in computer technology were explored, and educational user groups were contacted to determine current activities and their implications. Presented in essay form, the study includes discussions of the Information Age, international and national efforts in computer literacy, the pervasiveness of microcomputers, computers in public schools, the role of librarians/school media specialists, the concept of computer literacy, and computer literacy research conducted by the National Assessment of Educational Progress and the Minnesota Educational Computing Consortium (MECC). A 47-item selected bibliography is provided, as well as a chart showing the results of a survey of how state governments are promoting computer literacy and the MECC Revised Set of Instructional Objectives for Computer Literacy. (LMM)

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COMPUTER LITERACY IN PUBLIC EDUCATION: IMPLICATIONS FOR LIBRARIES AND LIBRARIANS/MEDIA SPECIALISTS

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A Research Paper Presented in
In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

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CHAPTER I

INTRODUCTION, STATEMENT AND SCOPE OF PROBLEM, PROCEDURE

Introduction

The decade of the 1970's saw major scientific and technological advances in American society. Among these developments in this area that have great potential benefits are those developments in the field of computer technology. Computers and their associated technology have profoundly influenced our way of life and there is evidence to suggest that they will continue this influence in the forseeable future.

Significant in the recent developments in computer technology has been the emergence of the phenomenon of personal computing in the mid-1970's. At present, the small, stand-alone, personal computer continues to evolve and proliferate. The personal computer, which is a microcomputer under the control of a single individual, together with the microprocessing capabilities that support it, have permeated almost every segment of our society. Recent developments in this technology have allowed manufacturers to produce general purpose computers affordable by many

individuals. Today, microcomputers are commonly found in homes, businesses, schools, colleges, and universities across the country. Sales of these small personal computers are increasing at a rate of 50 to 60 percent a year and are the leading product in the mushrooming field of electronic calculating and information equipment.[1]

Statement of the Problem

Microcomputing technology is attracting the attention of significant and increasing numbers of people. Recent estimates predict that almost three million personal computers will be sold this year.[2] The potential and to some extent the realization of the capabilities of microcomputers are beginning to impact the field of public education.[3] Public school systems are currently being inundated with literature regarding hardware, software, and applications of computers within the school environment. While microcomputer use in the public schools is behind that of use in homes and businesses, the number of schools using microcomputers is growing. The National Center for Educational Statistics estimates that there are more than 50,000 computers in use in the nation's schools and the number is growing.[4] Concurrent to the proliferation of microcomputers in public schools has been the issue of computer literacy. Inherent in the concept of computer literacy are problems of

definition, interpretation, and status within the educational curriculum. The introduction and proliferation of microcomputing in education, together with the growing issue of computer literacy, has implications for the school librarian/media specialist as well as for all educators within our public school system.

Scope of the Problem

Personal computing is making an impact on public education. Decreasing costs and a growing range of capabilities are only two of many factors which are allowing microcomputers a "grass roots" level introduction of computing into our public education system. Neither educators nor the general public have kept pace adequately with advances in computer technology, its potential impact on society or its role in public education. However, the advent of computer usage in our society has prompted the recognition of the need for widespread understanding of computers. Because the public school system is the logical institution for such activity, efforts are underway urging that an educational effort be launched to teach people about computers. The concern for an understanding and awareness of computers is embodied in the term "computer literacy." The concept of computer literacy as a relevant need in our society and as an educational goal which deserves to be developed and

implemented in our curriculum, is the object of this study. The public school librarian/media specialist, as a member of the instructional team, will play a significant role in achieving computer literacy. Because educational strategies designed to create or improve computer literacy are extremely diverse and often ill-defined, an understanding of the concept is prerequisite for librarians and other educators charged with the implementation and realization of that goal.

Procedure

To fully study the concept of computer literacy a review of the current literature was made. Emphasis was placed upon information printed from 1978 to the present which would highlight the development, growth, and present status of computer literacy in the domain of public education. Recent developments in computer technology, resource groups, and research activities were explored. Professional, trade, and technical literature was reviewed and educational user groups contacted to determine current activities and implications relevant to the study. Copies of selected materials utilized or related to this study are included in the appendices. The essay form of presentation is utilized to present this study.

CHAPTER II

THE ADVENT OF COMPUTING

The Information Age

In the last few years there has been a growing concern for the public's limited understanding of computers that has prompted many computer experts, educators, and others to propose programs to help educate future citizens. A large part of this concern for educating the public in their understanding of computers is founded upon the premise that our society has entered the "information age." Andrew Molnar, Project Manager for the National Science Foundation, has been an eloquent advocate of this premise. Molnar recently reported that as a nation we have moved from being a predominately industrial society to being an information society.[5] In such a society described by Molnar and others, information has become a national commodity and a national resource and has changed the very nature of work. Today, more than half our Gross National Product and half of our jobs are in the information industry.[6] Molnar maintained that computers are the basis of this information industry.[7] Former President Jimmy Carter has stated:

> The production and distribution of information is a significant factor in our economy. A technological explosion is reshaping the way information is stored and communicated, while rising costs and limited resources strain public institutions that make information accessible . . . as the largest user of computer technology in the world, the federal government plays a major role in deciding how this technology is applied everywhere.[8]

The transition to an information based society has given further impetus for the inclusion of computer literacy as a goal in public education.

International Efforts in Computer Education

The United States is no longer alone as a user of high technology or as a leader in computer education. The movement toward computer education has come to the forefront all over the world.

The United Kingdom, for example, has set up a three-year national program to develop micro-electronic education in schools with a supporting budget of approximately 24 million dollars.[9] The aim of this program is to guide changes in the curriculum and to promote computer assisted learning and the study of control and information technology.[10] Within this program, an additional 10 million dollars is available to help every school in the country to acquire at least one microcomputer.[11]

In the Netherlands, a government sponsored institution called TELEAC is providing multi-media education for

adults in various areas of computer science making use of public television and radio broadcast networks.[12] It is reported that large numbers of people have viewed courses which bring them up-to-date on new developments in technology and the influence it will have on their lives.[13] Because many homes have microcomputers, a course consisting of television lessons, a detailed course book, homework, and computer terminal assignments have been prepared.[14]

The Republic of China is beginning to train its students through a microcomputer based BASIC instruction system.[15] In Shanghai, at the Institute of Educational Technology, work is being done to create lessons that will teach BASIC through computer assisted instruction.[16]

The French are installing 10,000 microcomputers in their high schools throughout the country as part of their ten-year plan to make their country proficient in computer literacy.[17]

National Efforts in Computer Literacy

In this country many notable groups are supporting widespread public understanding of computers in an information/computer based society. Many of these groups have advocated that strong educational efforts be launched in our schools to teach people about computers. For instance, in 1977, the National Council of Supervisors of Mathematics

issued a position paper on basic mathematical skills describing important components of school mathematics. Their statements in this paper included computer literacy as one of ten basic skills. It stated:

> It is important for all citizens to understand what computers can and cannot do. Students should be aware of the many uses of computers in society, such as their use in teaching, learning, financial transactions and information storage and retrieval. The "mystique" surrounding computers is disturbing and can put persons with no understanding of computers at a disadvantage. The increasing use of computers by government, industry, and business demands an awareness of computer uses and limitations.[18]

The May 1978 issue of Mathematics Teacher included another important position statement regarding "Computers in the Classroom" (prepared by the Instructional Affairs Committee and approved by the NCTM Board of Directors), which stated:

> An essential outcome of contemporary education is computer literacy. Every student should have first hand experience with both the capabilities and the limitations of computers through contemporary applications. Although the study of computers is intrinsically valuable, educators should also develop an awareness of the advantages of computers both in interdisciplinary problem solving and as an instructional aid.[19]

While it is evident that these groups are advocating the general concept of computer literacy, their statements do little to clarify what should be contained in that

concept. Other groups and individuals have, however, been more explicit in their statements of possible components, experiences, and objectives that should be included in the concept of computer literacy. Also appearing in the literature have been attempts at measuring and evaluating computer literacy among public school students.

In anticipation of future emphasis on computer literacy and in recognition of this as a topic in which performance should be monitored, the National Assessment of Educational Progress included exercises that dealt with several aspects of computer literacy in the 1977-78 mathematics assessment.[20] In a similar vein, the National Science Foundation through its Research in Science Education Program has funded the Minnesota Educational Computing Consortium (MECC) in a number of research endeavors concerning computer literacy.

The Special Projects Division of MECC is undergoing a series of related computer literacy projects. During a two-year period from 1978 to 1980, MECC, a statewide educational agency, carried out a project entitled "A Study of Computer Use and Literacy in Science Education." Included in this project was the development of a published set of instructional objectives for achieving computer literacy.[21]

A second project of MECC was another research activity which consisted of a statewide assessment of Minnesota

students in grades 8 and 11. That project, entitled "Computer Awareness and Literacy of Adolescent Students: An Empirical Assessment," involved the development and construction of the Minnesota Computer Literacy and Awareness Assessment as an instrument designed for the assessment of computer literacy among secondary school students.[22]

The most recent computer literacy project of MECC is a developmental rather than a research project. The project extends for two and a half years, terminating in March, 1983. That project, entitled "Instructional Materials for Computer Literacy" is also funded by the National Science Foundation. In carrying out this project, MECC plans to design, develop, test, and evaluate an integrated set of twenty-five student learning modules for science, mathematics, and social studies courses in secondary schools.[23] The central theme of these learning packages will be the computer: how it works, how it is used, its impact on the individual and society, and the implications of its use for the future.[24]

CHAPTER III

MICROCOMPUTERS AND COMPUTER LITERACY

While there is no carefully articulated national consensus on the role and importance of computer technology for education, there is widespread agreement on its many potential benefits.

In 1978, the subcommittee of the House Committee on Science and Technology issued a report, Computers and the Learning Society, based upon extensive hearings. The report found widespread agreement for the idea that properly implemented uses of computer technology in the schools can make significant improvements in teacher effectiveness and student learning, and that the microcomputer revolution very likely will make personal computers commonplace in the home in the near future. The report also concluded that the costs of general purpose computer systems will be dramatically reduced, thereby creating a unique educational opportunity.[25]

The Pervasiveness of Microcomputers

Accurate figures or even reasonable estimates on the use and numbers of microcomputers in education at the

present time are difficult to obtain. In an area changing as rapidly as computing, it is difficult to describe the extent of present usage or to predict future usage. Data from the literature serve to illustrate the rapid, dramatic, and at times conflicting, change in numbers of computers in our society. In 1975, the first year that microcomputers were available, estimates indicate about 20,000 units were sold.[26] In 1979, annual personal computer sales were reported to have reached 350,000 units, with an estimated value of approximately 500 million dollars.[27] It was reported in 1980 that over 600,000 were sold and estimated that more than one and a quarter million are in use today.[28] David Moursund stated in the September 1981 issue of Computing Teacher that there are approximately 100,000 microcomputers currently installed or on order for use in elementary and secondary schools in the United States.[29] However, data from the National Science Foundation disagree with that estimate and place the total number of microcomputers in elementary and secondary schools at 200,000 and project one million units in the schools by 1985.[30] Additional data reporting educational sales of microcomputers for the year 1981 estimate that 70,000 machines were sold.[31] A relatively new journal, Electronic Learning, recently surveyed all of the 50 state educational agencies, focusing on how state governments are promoting computer

literacy in the schools. The results of that survey, which include estimates on the number of computers in each state, are contained in Appendix A.

Computers in the Public Schools

Although research in the field of computer technology rapidly goes out of date, it is still useful, if not accurate, to use these data to gain an insight as to where we may be headed in the field of education. The literature reports that the use of computers in general, and microcomputers in particular, is spiraling.

In a survey of all 67 public school districts in the state of Florida, in which 55 schools responded, 69 percent expected an increase in the use of computers for instructional purposes within the next 5 years. Over 80 percent of the administrators in that survey expected their districts to be using computers for instruction within 5 years.[32]

North Carolina reported in the fall of 1980 that over 350 schools in their state were using microcomputers. In the Piedmont area, a State Department of Public Instruction survey found that over 75 percent of all public school systems were using computers and the number of schools with microcomputers seems to be growing geometrically, approximately doubling each year.[33]

The Minnesota Educational Computing Consortium (MECC) reported that as of February 1981, there were

approximately 2,000 computer terminals and 2,500 microcomputers located across the state in most public schools, all community colleges, public universities, and many of Minnesota's private schools.[34]

The Role of Librarians/School Media Specialists

Research concerning the role of the school librarian/media specialist and implications for utilizing computer technology as a part of the media specialist's responsibility is also emerging. In Texas, a group of practicing school media specialists was surveyed to determine their background in computer science and their attitudes about the use of computers in society and education.[35] Results of the survey indicated that school media specialists have had little training in computer technology.[36] Only 31 percent of the media specialists surveyed had taken educational courses in the computer sciences.[37] In that survey, media specialists were generally positive in their attitudes when judging the impact the computer had on the quality of their lives (see Table 1).[38] As a group they saw the usefulness of using a computer in credit rating data banks, but they also saw greater applications for the computer. Most felt that computer technology would improve such aspects as health care, law enforcement and education.[39]

TABLE 1

RESPONSE PERCENTAGE OF MEDIA SPECIALISTS' ATTITUDES CONCERNING COMPUTER IMPACT ON THE QUALITY OF LIFE (N = 29)

Statement	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Credit rating data banks are a worthwhile use of computers	6.9	44.8	34.5	6.9	6.9
Computers will improve health care	27.6	51.7	13.8	6.9	0.0
Computers will improve law enforcement	27.6	55.2	17.2	0.0	0.0
Computers will improve education	41.4	41.4	10.3	6.9	0.0
Computers can teach mathematics	13.8	62.1	6.9	13.8	3.4
Computers can teach language arts	3.4	62.1	10.3	17.2	6.9

The role that the computer will have in the school media center is significant. Most of the media specialists surveyed indicated practical uses for the computer in the school media center.[49] (See Table 2.)

Primarily, this group felt that the computer would be useful in daily management of the media center. Specifically, these media specialists felt that the computer could be used to assist teachers in material selection and in the design of instructional programs. On a more practical point, the group perceived the future role of the media specialist as one of developing computer programs for the classroom teacher. The group was in near total agreement that members of the school media profession should have training in computer programming.[41]

In conclusion, media specialists in this survey were aware of the impact the computer had on our daily living. As a group, they generally accepted the computer and the role it will play in their future. In relation to education, the computer was seen as being an important tool and to be used to teach a variety of subjects. The survey, albeit small, indicated that as the computer moves into the classroom the media specialist will play an increasingly important role in implementing this new educational system.

TABLE 2

RESPONSE PERCENTAGE OF MEDIA SPECIALISTS' ATTITUDES CONCERNING THE MEDIA CENTER AND THE COMPUTER (N = 29)

Statement	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
If there was a computer terminal in the center, it would help administer the center	41.4	34.5	17.2	6.9	10.0
Computers can select appropriate learning materials for teachers	20.7	55.2	6.9	6.9	10.3
Computers can maintain equipment and material inventories for a media center	44.8	51.7	3.4	0.0	0.0
Media specialists should have academic training in computer programming	24.1	62.1	6.9	6.9	0.0
Computers can design instructional programs	6.9	51.7	6.9	20.7	13.8
Computers can effectively search a library's periodical collection	37.9	62.1	0.0	0.0	0.0
Media specialists, someday, will have to develop computer programs for teachers	13.8	65.5	10.3	3.4	6.9

The Concept of Computer Literacy

In perusing the literature on the issue of computer literacy, one finds a great diversity in attempts to define the concept. While there is general agreement that computer literacy is the ability of an individual to understand and deal effectively with computers there is no consensus on the specific knowledge, attitudes, and skills one needs in any given situation involving computers or computer supported applications. The literature revealed that different authors place priorities on very different aspects of computing. On one extreme the emphasis is placed upon using hardware and programming; at the other extreme, emphasis is placed on awareness of issues and applications. However, most authors generally avoid trying to formulate a universally accepted definition and instead, promote a combination of these ideas.

David Moursund, Chairman of the Association for Computing Machinery's Elementary and Secondary School Subcommittee, stated that:

> Computer literacy refers to a knowledge of the non technical and low technical aspects of computers, and of the social, vocational, and educational implications of computers.[42]

For instance, Moursund maintained that the student taking auto mechanics courses should develop a working knowledge of

the application of computers in this field. Likewise, the student taking advanced mathematics courses should have a working knowledge of the capabilities and limitations of computers as an aid in solving mathematical problems encountered in these courses. Thus, the student develops what Moursund calls a "working" level of knowledge of computers that prepares him/her to use the computer as a tool in learning the particular subject matter of their choice.[43]

Anderson and Klassen of MECC offered a broad definitional approach to computer literacy. They proposed a definition of computer literacy which incorporated a knowledge of computers, the social implications of that knowledge, and a recognition of the need for skills in communicating with computers.[44] Their definition stated:

> Computer literacy is whatever understanding, skills, and attitudes one needs to function effectively within a given social role that directly or indirectly involves computers.[45]

Anderson and Klassen saw a major application of this approach in that it allowed the term computer literacy to apply to many dimensions of the total concept. Using their definition, courses designed to teach different aspects of computer literacy may be called computer literacy courses, but the label should be used if, and only if, the material, ideas, skills, etc., satisfy the needs of the particular

students involved.[46] Therefore, utilizing this approach to computer literacy, it would be the responsibility of the teacher to identify and satisfy the needs of the targeted students.

Computer Literacy Projects

National Assessment of Educational Progress

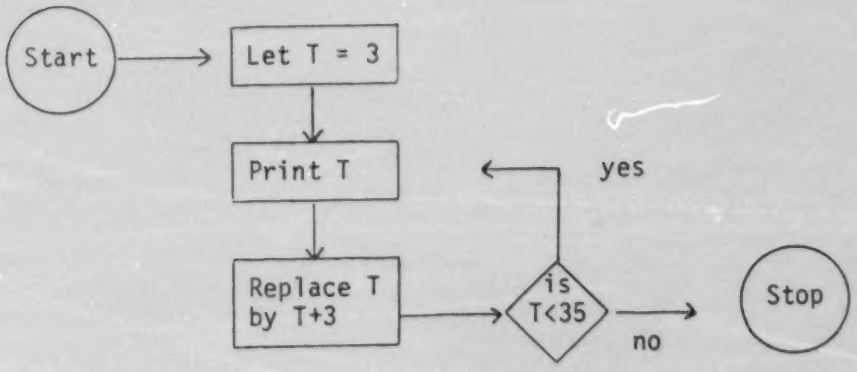
Several substantial (in terms of total number surveyed) research projects on computer literacy, have been completed in the last few years. The National Assessment of Educational Progress (NAEP) included exercises designed to measure aspects of computer literacy in their 1977-78 mathematics assessment.[47] These exercises included both cognitive and affective exercises, and were administered to 13- and 17-year-olds.[48] A total of approximately 27,000 13-year-olds and 27,000 17-year-olds participated in the NAEP assessment.[49] Contained in that assessment were four cognitive exercises which assessed students' knowledge of two aspects of computer literacy. The aspects of computer literacy assessed were flowcharting and computer programming. The two flowcharting exercises were similar in that each asked students to determine the output of a given flowchart. Table 3 presents results for one of these exercises.[50] The flowchart was organized in such a manner

TABLE 3

FLOWCHARTING EXERCISE AND RESULTS

Sample Exercise:

This is a flowchart.



What would be printed in the output?

	Percent Responding						
Age 13	5	11	10	7	11	9	47
Age 17	6	13	7	6	22	6	39

0	0	0	0	0	0	0
3	6	33	3	3	3	I don't know
			3	6	6	
			3	9	9	
			3	12	12	
			3	15	15	
			3	18	18	
			3	21	21	
			3	24	24	
			3	27	27	
			3	30	30	
			3	33	33	
					36	
					39	
					42	

that students were required to understand an assignment statement (T=T+3) and a loop process that required a decision about whether an obtained number was less than 35. The low level of performance and the high percentage of students who responded "I don't know" to these exercises suggested either that students have had little opportunity to develop knowledge about flowcharts in general or, more specifically, about flowcharts containing a loop.[51]

Interpreting a computer program presented in a computer language (BASIC) was the other aspect of the cognitive dimension of computer literacy assessed by the NAEP. Two programming exercises were included; the results obtained on the released exercises are presented in Table 4. This programming exercise and the flowchart exercise were designed to be parallel exercises. Practically the same percentage of 17-year-olds were correct on both exercises, but slightly more 13-year-olds were correct on the programming exercises than on the flowcharting exercise.[52]

The high percentages of "I don't know" responses on the four cognitive exercises suggested that most students recognized their lack of knowledge about the subject of computers and chose not to even attempt the exercise. The results are substantiated by background data and are not surprising when only 14 percent and 12 percent of the 13- and 17-year-olds, respectively, indicated that they had

TABLE 4

PROGRAMMING EXERCISES AND RESULTS

Sample Exercise:

This is a basic program.

```
 5  LET          T = 3
10  PRINT        T
15  LET          T = T+3
20  IF           T < 35 THEN 10
25  END
```

What would be printed in the output?

	Percent Responding						
Age 13	5	3	8	8	14	9	54
Age 17	4	4	3	4	21	5	57
	0	0	0	0	0	0	0
	3	6	33	3	3	3	I don't know
				3	6	6	
				3	9	9	
				3	12	12	
				3	15	15	
				3	18	18	
				3	21	21	
				3	24	24	
				3	27	27	
				3	30	30	
				3	33	33	
						36	
						39	
						42	
						.	
						.	

studied mathematics through computer instruction.[53] Seventy-one and 62 percent of the 13- and 17-year-olds, thought that computers would be useful in teaching mathematics, although only 12 and 25 percent had access to computer terminals for learning mathematics in their schools.[54] The results indicated that most 13- and 17-year-old students have not used computers in their mathematics classes and furthermore, most have had little experience of any kind with computers.[55] Although about two-thirds of both groups thought computer programming would be a useful topic to study in mathematics classes, only 8 and 13 percent of the 13- and 17-year-olds, respectively, said they knew how to program a computer. This lack of experience explains the low levels of performance on the cognitive computer exercises that dealt with flowcharts and programming.[56]

Several exercises were included in this assessment that ascertained students' awareness of potential uses of computers, their beliefs about the impact of computers on society, and other commonly held beliefs about computers relative to computer mystique.[57] Table 5 is a summary of the results of an exercise describing the potential usefulness of computers in various situations. Judging from the response to items (a), (b), and (e), it appeared that students are aware of the routine uses of computers encountered in their everyday experiences, but do not

TABLE 5

RESULTS ON A COMPUTER-AWARENESS EXERCISE

How much would a computer help in:	Age	Percent Responding: Computer helps a lot	Computer helps a little	Computer does not help
a) calculating and printing bills for a credit card company;	13	72	24	3
	17	84	14	1
b) keeping track of a car maker's inventory;	13	48	42	10
	17	60	35	5
c) telling which food tastes best;	13	3	6	90
	17	1	6	93
d) predicting election results;	13	41	35	24
	17	43	42	16
e) alphabetizing list of names;	13	66	27	7
	17	79	16	5
f) writing a novel;	13	7	18	75
	17	2	11	87
g) diagnosing diseases?	13	25	33	42
	17	24	43	33

realize that computers may be used in solving more complex problems.[58]

A fourteen-part exercise asked the students to respond along 5-point scales of "Strongly Disagree" to "Strongly Agree" when presented with statements designed to reflect specific beliefs and feelings about computers. Results indicated that students were knowledgeable about the mechanics of computer operation; over 85 percent of both age groups knew that computers had to be programmed to follow precise instructions.[59] Table 6 summarizes some other results concerning students' feelings about computers. Statement (a) generated the greatest disparity between the two age groups of any of the statements. More than any of the other parts of this exercise, statements (c), (d), and (e) represent students' value judgements about the possible impact of computers on society.[60] Perhaps the most surprising results in the NAEP assessment were obtained in response to statement (e), where three-fourths of both age groups agreed that computers were ultimately going to be responsible for the operation of almost everything.[61]

In conclusion, the results of the exercises contained in the NAEP assessment indicated that most 13- and 17-year-old students have had little firsthand experience using or programming computers whether inside or outside the mathematics classroom. Their lack of experience

TABLE 6

RESPONSES TO STATEMENTS OF FEELINGS ABOUT COMPUTERS

Statement	Age	Percent Responding		
		Disagree	Undecided	Agree
a) Computers are suited for doing repetitive, monotonous tasks.	13	14	39	47
	17	11	64	25
b) Computers have a mind of their own.	13	56	14	30
	17	67	15	18
c) Computers dehumanize society by treating everyone as a number.	13	31	37	32
	17	31	28	41
d) The more computers are used, the less privacy a person will have.	13	42	22	35
	17	40	24	35
e) Someday most things will be run by computers.	13	10	15	76
	17	9	12	79

does not reflect, however, lack of basic knowledge about how computers operate nor do they lack opinion about computers. It is difficult to establish whether the students' patterns of responses were indicative of acceptable levels of computer literacy. Some students may have responded in accordance with their own perceptions of computer mystique rather than from a reasoned point of view; therefore, no substantive conclusions can be drawn about student levels of computer literacy from this assessment.[62]

Minnesota Educational Computing Consortium

Established in 1973, the Minnesota Educational Computing Consortium (MECC) has done and is continuing to do research in a range of activities related to computer literacy and the use of computers in schools. Already mentioned, the first MECC project entitled "A Study of Computer Use and Literacy in Science Education" involved a teacher survey, a field study, and an experiment in computer assisted instruction.[63] Part of the data from that project are relevant to this paper and provide valuable insight for librarians as well as other teachers influencing the structure and content of individual courses and curricular programs.

The teacher survey which consisted of a questionnaire was sent to all 6,837 Minnesota secondary (grades 7-

12) teachers in mathematics, science, and business education. From this mailing, a total of 3,576 questionnaires (52 percent) were returned.[64] Table 7 summarizes the responses of users/non-users to statements in the survey designed to measure teachers' attitudes toward computing.

Results from the teacher survey indicated that teachers strongly support the need for general, minimal computer literacy among secondary school students. Eighty-five percent of the teachers agreed with the statement that "every secondary school student should have some minimal understanding of computers." An even larger number of teachers (93 percent) agreed that "every secondary school student should learn about the role that computers play in our society."[65]

The data from the teacher survey substantiate that computers are rapidly moving into the classrooms. One of every two (50 percent) teachers in the sample reported that they had used computers at some time in their classes. Overall, the teachers responding in the survey felt positive about the value of computers in education but many also felt inadequately prepared to make decisions about using computers in their classrooms.[66]

The MECC field study involved three major accomplishments. They consisted of the following: (1) the development of a conceptual framework for computer literacy

TABLE 7--Continued

Statement		Strongly Disagree %	Disagree %	Undecided %	Agree %	Strongly Agree %	n
5. The effort necessary to integrate computers into my teaching is an inefficient use of my time.	USER	16	47	22	12	4	1286
	NON	6	29	40	19	6	2485
	ALL	9	35	34	17	5	3771
6. Computers can be a useful instructional aid in many subjects other than mathematics.	USER	1	1	6	51	42	1288
	NON	1	2	13	63	21	2507
	ALL	1	1	11	59	28	3795
7. Computers provide more disadvantages than advantages in education.	USER	30	51	11	5	3	1279
	NON	15	20	29	6	2	2500
	ALL	20	49	23	6	2	3779

NOTE: "Users" teach with, and/or about computers.

expressed in terms of learning objectives, (2) the development, validation and administration of a computer literacy test called the Computer Literacy Questionnaire, and (3) the testing before and after computer related instruction of approximately 1,100 secondary school students in Minnesota.[67]

The comprehensive set of computer literacy objectives developed by MECC provides users of their research with a definition of computer literacy expressed in concrete learning outcomes. The development team in charge of the project identified six basic dimensions that were common elements to most definitions of computer literacy. Succinctly stated, the dimensions identified were: hardware, software and data processing, programming and algorithms, applications, impact, and attitudes and values. After these dimensions were established, an extensive list of topics for each was constructed and subsequently used as the basis for the final set of objectives.[68] The revised set of computer literacy objectives is listed in Appendix B.

Upon completion of the set of computer literacy objectives, the MECC research team devoted extensive effort to the development and validation of a comprehensive computer literacy assessment instrument. The result of this effort was an assessment instrument called the Computer

Literacy Questionnaire. As an integral part of the field study, the Computer Literacy Questionnaire was administered to over 1,100 students in 51 carefully chosen classrooms.[69]

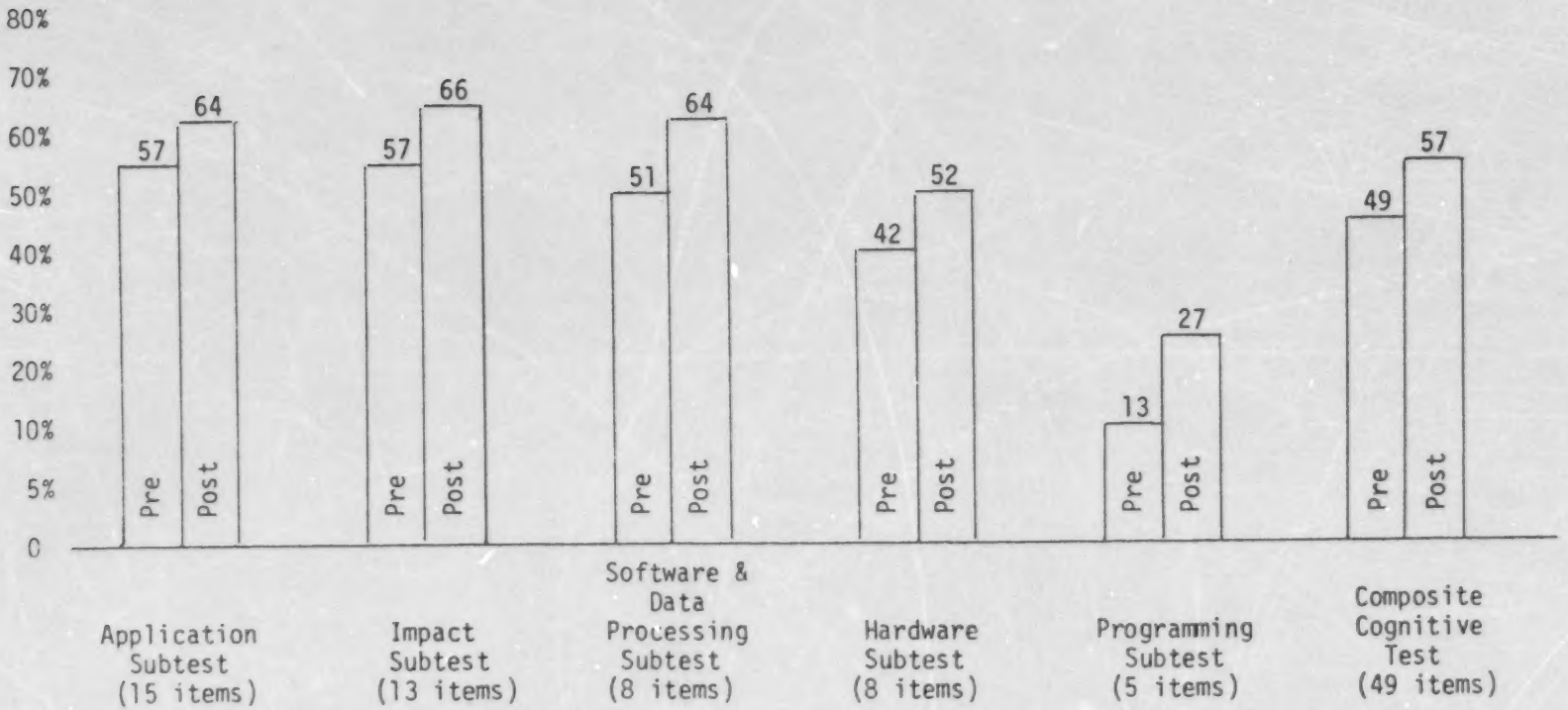
Data from testing in the field study provided valuable insight concerning computer literacy among students. Table 8 summarizes results on five cognitive subtests and the composite cognitive test collected in the administration of the Computer Literacy Questionnaire.

As shown in Table 8, the vast majority of secondary school students could not prepare computer programs. Concerning hardware, the students did not seem to understand much about the essential functions of a computer as indicated by the relatively low number correct on that subtest. The average performance on the final composite cognitive computer literacy test was only 57 percent correct.[70]

In conclusion, data from the field study indicated that although students gained significant knowledge about computers in secondary school computer courses, they often leave these classes without becoming computer literate in the comprehensive sense of the term. The analysis of data from the students showed that the approach and content selected by the teacher do make a difference on the acquisition of computer literacy. The amount of classroom time devoted to computers also has a separate effect in raising the computer literacy of students.[71]

TABLE 8

AVERAGE PERCENT CORRECT ON COMPUTER LITERACY COMPOSITE TEST AND SUBTEST AMONG STUDENTS BEFORE (PRE) AND AFTER (POST) COMPUTER COURSES (N = 929)



Since the first MECC field study, both the original assessment instrument (the Computer Literacy Questionnaire) and the list of objectives for computer literacy have been revised. The current assessment instrument for computer literacy is the Minnesota Computer Literacy Awareness Assessment (Forms 1 and 8). In 1979, Form 1 of this test booklet was given to grade 11, and Form 8 administered to grade 8 in a statewide assessment of Minnesota students.[72] The conclusions and findings of this second MECC computer literacy project have not at this time been released. The revised Minnesota Computer Literacy Awareness Assessment (Form 1) is contained in Appendix C.

In revising the set of objectives for computer literacy the officials at MECC stated:

> Both the technological context and the educational environment are changing very rapidly. As a result we feel compelled to revise the objectives to bring them up-to-date and in order to re-orient them to our new project of developing instructional materials . . . objectives are generally specified at one of three different levels: (1) broad goals for learning, (2) informational objectives or desired learning outcomes for a course or instructional sequence, and (3) behavioral objectives for a specific lesson or module. In our current revision of objectives for computer literacy we are specifying objectives at the second level, informational objectives for an instructional sequence.[73]

It should be noted that the current set of objectives (see Appendix B) are grouped into eight areas or domains which are summarized as follows:

1. APPLICATIONS. This area covers the multitude of social and organizational areas into which computers have been integrated. It also covers the general considerations for applying computers to new situations.

2. HARDWARE. This domain deals with the basic vocabulary of computer system components. How extensive this knowledge should be depends upon the social role of the learner.

3. IMPACT. The domain of computer literacy encompasses the social effects of computerization, including both the positive and negative impacts of computers on society.

4. LIMITATIONS. This domain is distinguished from the applications domain because of the focus on developing a general sense of the capabilities and limitations of computing machines. Examples of computer limitations include the facts that computers do not have feelings and consciousness, nor are they able to make value judgements.

5. PROGRAMMING/ALGORITHMS. This domain deals with the ability to read, modify, and construct algorithms and programs.

6. SOFTWARE AND DATA PROCESSING. This area includes vocabulary relevant to software, information processing, and data.

7. USAGE. While the foregoing areas are largely cognitive in emphasis, this domain involves motor skills for sequencing the execution of certain tasks on the computer terminal.

8. VALUES AND FEELINGS. The affective domain centers on developing positive attitudes toward personal use of computers as well as balanced attitudes toward computers as a social force.[74]

The domains of LIMITATIONS and USAGE are new additions to the six basic dimensions that were identified in the first MECC computer literacy project. Also, the current

set of objectives are numbered with two values, the first one designating the objective as elementary (1) or advanced (2), and the second value being a sequence number. This was done because there are limits to the amount of instructional material that can be contained in a curriculum, and as such, the designation as elementary or advanced becomes important. The elementary objectives in such circumstances become priority objectives.[75]

CHAPTER IV

CONCLUSION

Computers have rapidly assumed a powerful role in our society. Arthur Luehrmann and Andrew Molnar, among others, have written that the general public's ignorance of computer usage constitutes a national crisis. Although one may not agree with their statements, significant technological developments in the last few years have enhanced the proliferation of computers in many sectors of our society.

Particularly in the area of microcomputing, where lower costs and increasingly greater capabilities are becoming commonplace, the growth rate in numbers of these computers sold has been near revolutionary. As the proliferation of computers in our society occurs, the concept of computer literacy has gained prominence. A survey of the literature included in this paper indicates that both the proliferation of microcomputing and the movement toward the inclusion of computer literacy as a goal in education are likely to continue in the future.

In a recent survey of all 50 state educational agencies, Andrew Calkins identified eight states as leaders

in the movement for support of computer education at the state government level.[76] The state of Minnesota via the Minnesota Educational Computing Consortium is taking the lead in providing training, materials, and research to schools throughout the state.

The findings of this research paper indicate that although computer literacy is not at present a universal goal in education, there is widespread and powerful support for it to be included in the modern school curriculum. Data from the literature also reveal that the number of schools acquiring microcomputers is increasing day by day. Gerald Gleason, while on a sabbatical leave to study the microcomputer field, found that virtually every school institution he visited already had access to microcomputers.[77] Prestigious organizations such as the National Science Foundation estimate the number of microcomputers already in the public schools to be in the hundreds of thousands. While computers in general, and microcomputers in particular, in education, are no panacea, the multitude of uses for them within the school environs has become an accepted teaching technique.

The school librarian/media specialist has traditionally played a central role in the achievement of educational goals and objectives within the school environment. The implications brought about by the movement to include

both computer literacy and computer technology in education, has changed the role of traditional school librarianship. A study of the literature reveals explicit descriptions of a wide range of applications for the computer in the school library, as well as other areas in the school curriculum. Theodore Hines, in cooperation with Lois Winkel, Rosann Collins and Francis Harvey, recently described thirty-one different applications for microcomputers for libraries.[78] As Nicklin and Tashner noted in the Spring, 1981, issue of the School Media Quarterly, library media specialists will be called upon to offer advice, make acquisitions and coordinate use of microcomputers.[79] Smeltzer's survey of media specialists' attitudes toward computer technology indicated that a future role of the media specialist may include developing computer programs for the classroom teacher.[80] As a result of this growing phenomenon, school librarians/media specialists have a need to develop realistic perspectives concerning computer technology and the issue of computer literacy.

The literature surveyed in this paper substantiates that computer literacy as an objective in education has yet to be achieved. Two systematic and comprehensive attempts at identifying levels of computer literacy among students have appeared in the literature. The first effort conducted by the National Assessment of Educational Progress

(NAEP), and the later field study conducted by the Minnesota Educational Computing Consortium (MECC), provided valuable data for assessing computer-related knowledge. Data from the MECC field study support the earlier findings of the NAEP assessment dealing with computer literacy. Both evaluations indicate that at best, comprehensive computer literacy among students is limited to only a few students in our schools.

A major obstacle to achieving computer literacy that was identified in the literature was the lack of trained educators knowledgeable about computers in the schools. Data from the literature showed that media specialists as well as other educators felt inadequately trained in computer usage.

To facilitate learning in this area, librarians and other educators need to learn about computers and their educational uses. Whenever possible, computers should be placed in the libraries and classrooms of the schools and help be given to students in learning about their use and function. If librarians/media specialists are to continue to help and support other curricular areas within the school as they traditionally have, much more needs to be done. At the present time, an opportunity exists for librarians/media specialists to affect both computer usage and the issue of computer literacy within the educational

environment. The task of those in the field is to rise to this challenge and add computer literacy to their list of services provided.

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APPENDIX A

HOW STATE GOVERNMENTS ARE PROMOTING COMPUTER LITERACY

HOW STATE GOVERNMENTS ARE PROMOTING COMPUTER LITERACY

Note: The survey does not represent an attempt to measure the actual amount of local or district-wide activity or commitment to computer literacy, rather it focuses on the degree to which state government was offering tangible support to those local activities. All data reported as of September 1, 1981.

State	Mandate	Statewide Use	Comments
AL	No	No survey conducted and none is planned.	Vocational and high schools offer a few introductory courses in computer science. Budgeting at local level.
AK	No, but State Board of Education will fund local programs in 1984.	Estimated 500 micros for 450 schools.	Micros used to link isolated districts. All 52 district superintendents share computer-run management system. Task force is planning how to implement 1984 objective.
AZ	No	No survey; estimated widespread use in all districts.	In-service training at local level through vendors and courses at state university. Budgeting local.
AR	No	1980 survey estimated 40-50 schools out of 370 had micros.	All budgeting at local level.
CA	No, but Board of Education has approved objective for computer literacy.	Survey due in November.	State textbook code requires that some materials shall provide information leading to computer literacy skills.

State	Mandate	Statewide Use	Comments
CO	No	New survey in progress. Last year, 91 of 181 districts responded: 450 micros in use.	All funding at local level.
CT	Proposed	109 micros used in 117 (out of 169 districts)	First step of statewide plan is to create "facilitators," one for each district. Training at six regional centers.
DE	No, but State Board of Education has taken active role.	210 micros or terminals used by 7,000 students in 95 (out of 241) schools.	Project Direct--statewide consortium set up in 1975. Operates large time-share systems with 4 minicomputers. All districts pay subscription to belong.
DC	No	Survey in progress.	Workshops being offered by individual teachers.
FL	Yes, effective July, 1981	New survey in progress; estimated 2,500 computers for 67 districts.	State DOE mandated to provide information; establish vendor contracts; conduct surveys, evaluate equipment. State funds used to build two Instructional Computing Centers.
GA	No	New survey in progress; "Almost half" of all 187 districts use computers.	All plans at beginning stages. Statewide coordinator being hired.

State	Mandate	Statewide Use	Comments
HI	Proposed	Est.: 1 percent of 165,000 students participating in programs of any kind.	Look for plan to be approved in 1984. Will provide funds for CAI, Literacy career information in high schools.
ID	No	100 micros in 115 districts.	State initiated some programs two years ago but ran out of funds. No ongoing projects now underway.
IL	No	One out of ten schools are using micros for CAI.	Set up state library of 4,000 programs.
IN	No	1981 survey: 149 out of 206 responding schools were using computers.	$450,000 in Title IVB funds spent last year in computer-related programs. State developing micro resource center for students as well as teachers.
IA	1972 mandate on data processing	No survey planned.	State DOE defines mandate as "Be informed first" objective. Regional units offer advice and rent hardware to schools.
KS	No	1,500 micros spread through 60 percent of all schools in 300 districts.	State DOE will create teachers' guide for use of micros in the classroom.
KY	No	Survey in progress.	State-level committee now working to determine needs of schools, developing software curriculum.

State	Mandate	Statewide Use	Comments
LA	No	Survey in progress.	Office of Management and Information Services was set up July 1, 1981.
ME	No	Survey in progress.	After survey, expect to take more central control of usage and purchasing.
MD	No	Estimated 22 out of 24 districts using micros.	State level task force examining different kinds of technology; will recommend to suit needs of local districts.
MA	No	50 percent of schools using micros for CAI.	State Board of Education has adopted special objective for 1982.
MI	No	Survey planned for 1982.	Regional Centers offer workshops.
MN	No, except through granting of funds	Estimated 95 percent of all students exposed to computers.	For eight years, Minn. Educational Computing Consortium has promoted awareness among educators, individual communities. State provides 70 percent of all funding, for a total of $10 million spent to date.
MS	No	Estimated 15-20 schools out of 1,000 utilize computers.	Proposal to organize at state level is stalling due to lack of funds.
MO	No	Estimated half of all 550 districts own hardware.	Role of state in "fact finding stage." Leaning toward strong networking system, to help local districts.

State	Mandate	Statewide Use	Comments
MT	No	Estimated 30 percent of all students in 770 districts exposed to computers.	Statewide clearinghouse disseminates information; plans to build software lending library.
NE	No	Estimate 50 percent of all students exposed to electronic technology of some sort.	Educational Service Units run occassional workshops; they are trying to establish a network for software loan.
NV	No	No survey has been conducted. Micros mostly in secondary schools.	State has funded prototype system in a rural district, and the writing of software for the handicapped.
NH	No	Univ. of New Hampshire is conducting a survey.	State is waiting for survey results before acting.
NJ	No	No survey has been conducted.	Study group is now developing policy proposal for adoption by State Board of Education.
NM	No	No survey has been conducted.	State Board of Education mandates standards by subject area; next year's revision may include computer literacy.
NY	No	Survey is now being analyzed.	Bureau of Cooperative Ed. Services runs regional computer networks. Statewide guidelines may emerge from survey results.

State	Mandate	Statewide Use	Comments
NC	No	574 out of 2,114 schools use computers for CAI and computer literacy.	Instructional Computing Project conducts regional workshops; hopes to set guidelines in two years.
ND	No	Estimated 40-50 percent of state's 122,000 students are exposed to computers.	In 1977, State Dept. of Public Information issued computer curriculum guide.
OH	No	Survey in progress.	State level task force now observing local districts. 500 attended March 81 Computer Fair.
OK	No	No survey is planned.	State Board of Education has run a limited number of seminars and workshops. All activity at local level.
OR	No	1979 survey: 20 percent of 1,100 schools had micros.	Oregon Educational Computing Consortium disseminates information, helps districts acquire software.
PA	No	Estimated more than 75 percent of all schools have some form of technology.	State has organized centers for teachers and students, developed literacy courses, and assists with equipment purchasing. A micro/videotape research project is now underway.
RI	No	Survey has been proposed.	All action at the local level.

State	Mandate	Statewide Use	Comments
SC	No	Survey planned for August 1982.	State Board of Education sponsored a 40-hour pilot program this summer for training teachers in use of computers.
SD	No	50 percent of all schools use micros in 1982.	All math teachers required to have some form of computer training for certification.
TN	No	Survey anticipated soon.	State Board of Education now lists computer technology as a priority; it offers some in-service training through regional teacher centers.
TX	No	Survey has been proposed.	State has offered funding. Year-old Task Force for Technology in Education has developed comprehensive plan to support and provide communication channels between established local initiatives.
UT	No	40 percent of all students exposed to micros.	Proposal that all students should have an "awareness" of electronic technology awaiting State Board of Education approval.
VT	No	100 out of 650 schools have a computer.	State publishes a software catalog; may set up lending library.

State	Mandate	Statewide Use	Comments
VA	No	Survey in progress. Last year, 3-4 districts out of 137 "heavily involved."	State has contracts with Radio Shack and Apple.
WA	No	53 percent of all schools have computers or one per 302 students.	Task force now being established.
WV	No	Survey in progress.	All decisions at local level.
WI	No	249 out of 433 schools are using micros.	Regional centers provide training, technical assistance, help with financing.
WY	No	Over 75 percent of all 324 schools have micros. 50 percent of all students get some exposure.	State Board of Education will develop literacy course through Univ. of Wyoming. 1979 conference came up with set of 50 recommendations for state-level action.

APPENDIX B

MINNESOTA EDUCATIONAL COMPUTING CONSORTIUM
REVISED SET OF INSTRUCTIONAL OBJECTIVES
FOR COMPUTER LITERACY

MINNESOTA EDUCATIONAL COMPUTING CONSORTIUM REVISED SET
OF INSTRUCTIONAL OBJECTIVES FOR COMPUTER LITERACY

Applications (A)

A.1.1. Recognize that computers and computer-supported applications are used in a wide variety of ways to assist individuals, groups and institutions.

A.1.2. Recognize specific uses of computers or computer-supported applications in many of the following areas:

a. medicine and health care
b. law enforcement and criminal justice
c. education and training
d. engineering and design
e. business and banking
f. the office
g. transportation and traffic control
h. defense systems
i. weather prediction
j. recreation
k. government and politics
l. the home
m. the library
n. manufacturing
o. the creative arts
p. publishing
q. public utilities--telephone and power plants

A.1.3. Recognize that the following are common types of computer applications, and be able to give an example of each type.

a. information storage and retrieval--record keeping, data bases, etc.
b. simulation and modeling
c. process/machine control--robotics
d. computation (numerical/statistical analysis of data)
e. data processing
f. word processing
g. graphics
h. speech synthesis
i. artificial intelligence

A.1.4. Recognize the definition of and some advantages of computer simulation.

A.1.5. Recognize that computers are generally useful for information-processing tasks which require any of the following:

a. handling large amounts of information
b. rapid handling of information
c. accuracy
d. repetition
e. the storage of information in an accessible form

A.1.6. Recognize that some of the more important factors which limit and/or restrict computer use include:

a. cost (hardware, software, maintenance, conversion, etc.)
b. people's attitudes (fears, anxieties)
c. unavailability of suitable software/applications
d. hardware limitations--storage limitations, lack of peripherials, etc. [sic]
e. complexity of some computer-supported applications

A.1.7. Recognize that innovations in computer hardware and software continually expand the potential utility of the computer.

A.1.8. Identify some of the features of a computer-supported application which make it easy to use.

A.1.9. Recognize some advantages of using a computer for storage and retrieval of information (including continual up-dating and quick recall).

A.1.10. Recognize features and capabilities of personal microcomputer systems as compared to features and capabilities of large data processing systems.

A.2.1. Determine how computers and computer-supported applications can assist an individual as he/she plays various roles, i.e., consumer, worker, citizen; how such systems assist groups and organizations as they attempt to accomplish tasks and responsibilities.

A.2.2. Assess the feasibility, potential benefits, and hazards of a computer-supported application. (Cross reference in impact.)

A.2.3. Design and develop a computer-supported application that would be personally useful.

A.2.4. Recognize some general criteria for computer usage for a particular task (e.g., purpose, time and resource constraints, ethical or moral considerations, relevance).

Hardware (H)

H.1.1. Recognize that computer hardware refers to the physical components of computer systems.

H.1.2. Recognize that chips are small pieces of silicon that contain electronic logic networks called circuits, and that a computer can be made up on chips mounted on boards.

H.1.3. Identify at least five major functions of a general purpose computer system, namely input, output, storage or memory, control, arithmetic, and timing or clocking.

H.1.4. Recognize that CPU stands for Central Processing Unit, which is the part of the computer which carries out the essential and controlling tasks. The arithmetic, control, and memory units of a computer are generally regarded as comprising the CPU.

H.1.5. Recognize that the term "mainframe" refers to the CPU and its enclosure or to large computers.

H.1.6. Recognize that a microprocessor is a single chip containing all the electronic logic of a CPU.

H.1.7. Recognize that a microcomputer is a very small computer that uses a microprocessor for its Central Processing Unit.

H.1.8. Recognize that minicomputers are a range of computers larger than microcomputers and smaller than what is usually called "mainframes."

H.1.9. Identify the meaning of acronyms including ROM, RAM, PROM, EPROM, which identify different types of memory.

H.1.10. Recognize the characteristics of secondary storage systems including magnetic tapes, floppy disks, etc.

H.1.11. Recognize that keyboards, punch cards, tapes serve as input devices.

H.1.12. Recognize that display screens, printers, punch cards, tapes serve as output devices.

H.1.13. Recognize the function of some basic communications technology, e.g., networks, distributed networks, modem or acoustic-coupler.

H.1.14. Distinguish parallel and serial communications.

H.1.15. Recognize the rapid growth of computer hardware since the 1940s.

H.1.16. Recognize the distinctions among the following terms: bit, byte, register, and word.

H.1.17. Recognize both the loose and the precise definition of "K."

H.1.18. Distinguish and be able to identify special purpose from general purpose computers.

H.1.19. Identify similarities and differences between programmable calculators and computers.

H.1.20. Distinguish analog and digital computing operations.

Impact (I) Objectives

I.1.1. Describe some of the more common computer-related careers such as computer programmer, systems analyst, computer scientist, computer operator, key operator.

I.1.2. Recognize that computers and computer-supported applications have a major impact on the way ordinary citizens live, work and play.

I.1.3. Recognize that for at least the short term future, computers will continue to be made smaller while the amount of information they can hold will continue to increase.

I.1.4. Recognize that computers are used to commit a variety of serious crimes, especially stealing money and stealing information.

I.1.5. Recognize that identification codes (numbers) and passwords are a primary means for restricting use of computer systems, of computer programs, and of data files.

I.1.6. Recognize that procedures for detecting computer-based crimes are limited.

I.1.7. Identify some advantages or disadvantages of a data base containing personal information on a large number of people (the list might include value for research and potential for privacy invasion).

I.1.8. Recognize several regulatory procedures, e.g., privilege to review one's own file and restrictions on use of universal personal identifiers, which help to insure the integrity of personal data files.

I.1.9. Recognize that "privacy problems" are characteristic of large information files whether or not they are computerized.

I.1.10. Recognize that computerization both increases and decreases employment.

I.1.11. Recognize that computerization can personalize and impersonalize procedures in fields such as education.

I.1.12. Recognize that computerization can lead to both greater independence and dependence upon one's tools.

I.1.13. Recognize that alleged "computer mistakes" are usually mistakes made by people.

I.2.1. Plan a strategy for tracing and correcting a computer-related error such as a billing error.

I.2.2. Explain how computers make keeping track of people more feasible.

I.2.3. Recognize that even though a person does not go near a computer, he or she is affected indirectly because the society is influenced by computerization.

I.2.4. Explain how computers can be used to impact the distribution and use of economic, social and political power.

I.2.5. Identify and evaluate the positive and negative consequences of computer use in specific situations.

Limitations (L)

L.1.1. Recognize that computers are machines designed, built, and operated by humans to assist in many tasks.

L.1.2. Recognize that computers cannot make value judgments.

L.1.3. Recognize that computers cannot provide answers to every question.

L.1.4. Recognize that despite "artificial intelligence" computers cannot think in the way that we normally use the word "think."

L.1.5. Identify a number of things that computers cannot do or cannot perform efficiently.

L.2.1. Distinguish major differences between human capabilities and computer capabilities.

Programming/Algorithms (P)

P.1.1. Recognize the definition of algorithm and that flowcharts and programs are alternative forms for expressing algorithms.

P.1.2. Follow and give the correct output for simple algorithms expressed in words, flowcharts, or structure diagrams. The *algorithms would include some or all of the following: replacement; calculation; selection (decision points); repetition* (simple looping with iteration/recursion); input and output operations.

P.1.3. Given a simple algorithm, explain what it accomplishes, i.e., be able to interpret and to generalize. As in P.1.2. the algorithm could include replacement, calculation, selection, repetition, and input/output.

P.1.4. For simple programs written in a language such as BASIC or PASCAL, follow and give the correct output for the program. The programs would contain input/output, replacement, calculation, selection, and repetition.

P.2.1. Modify a simple algorithm or program to accomplish a new, but related, task. *This would include changing one or two statements* to solve a similar problem, and adding more statements to accommodate additional requirements.

P.2.2. Detect syntax and logic errors in an improperly functioning algorithm or program.

P.2.3. Correct syntax and logic errors in an improperly functioning algorithm or program.

P.2.4. Develop, with appropriate documentation, an algorithm or program for solvirg a specific problem.

P.2.5. Select an appropriate algorithm from a set of alternatives using criteria such as efficiency, elegance, and appropriateness.

Software and Information Processing (S)

S.1.1. Identify that software refers to computer programs and includes operating systems, compilers, and user (application) programs.

S.1.2. Recognize that digital computers operate upon information which has been encoded in binary, the coding system which can utilize the base 2 number system.

S.1.3. Recognize that a computer needs instructions to operate.

S.1.4. Recognize that a computer gets instructions from a program written in a programming language by a person.

S.1.5. Recognize that computer programs are sets of sequential instructions which perform many tasks such as printing, sorting, calculating.

S.1.6. Identify that the basic elements of an information processing system are input, processing, and output, in that order.

S.1.7. Identify the fact that data are symbols representing things.

S.1.8. Identify the fact that information is data which has been given meaning.

S.1.9. Identify the fact that communication is the transmission of information via coded messages.

S.1.10. Identify the need for data to be organized if it is to be useful.

S.1.11. Identify the fact that data processing involves the transformation of data by means of a set of pre-defined rules.

S.1.12. Recognize that computers process data by searching, sorting, deleting, updating, summarizing, moving.

S.1.13. Recognize that software refers to any nonpermanent sets of programs whereas firmware refers to software that has been made physically permanent.

S.1.14. Recognize that an operating system is software or firmware that performs file managing tasks such as loading programs, copying files, etc.

S.2.1. Select an appropriate attribute for ordering of data for a particular task.

S.2.2. Design an elementary data structure for a given application (that is, provide order for the data).

S.2.3. Design an elementary coding system for a given application.

Usage (U)

U.1.1. Connect a microcomputer or computer terminal to a power source and available storage units such as disks or tapes.

U.1.2. Interact with a computer in an online instructional learning situation involving drill and dialogs.

U.1.3. Use system commands for an available computer system (e.g., command to load, list, execute, save, and purge files).

U.1.4. Use program documentation to select and run library programs for specific tasks.

U.1.5. Enter, compile, and debug a simple stored program written in a "higher level" language.

Values (V)

V.1.1. Does not feel fear, anxiety, or intimidation from computer experiences.

V.1.2. Feels confident about his/her ability to use and control computers.

V.1.3. Enjoys and desires work or play with computers, especially computer assisted learning.

V.1.4. Describes past experiences with computers with positive-affect words like fun, exciting, challenging, etc.

V.1.5. Given an opportunity, spends free time using a computer.

V.2.1. Values the potential role of computers in meeting societal and institutional needs (e.g., making full, accurate information available for relevant decisions, problem solutions, or inquiries by private individuals; handling routine data collection/processing/monitoring tasks efficiently).

V.2.2. Values efficient information processing provided that it does not neglect accuracy, the protection of individual rights, and social needs.

V.2.3. Values computerization of routine tasks so long as it frees people to engage in other activities and is not done as an end in itself.

V.2.4. Values increased communication and availability of information made possible through computer use provided that it does not violate personal rights to privacy and accuracy of personal data.